



Electronic Voting and Counting System

Information Paper

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1 Introduction

In June 2000, the Department of Environment and Local Government invited tenders for the supply of an electronic voting and vote counting system. After a detailed evaluation of the proposals received, the Powervote/Nedap solution was selected, subject to satisfactory testing.

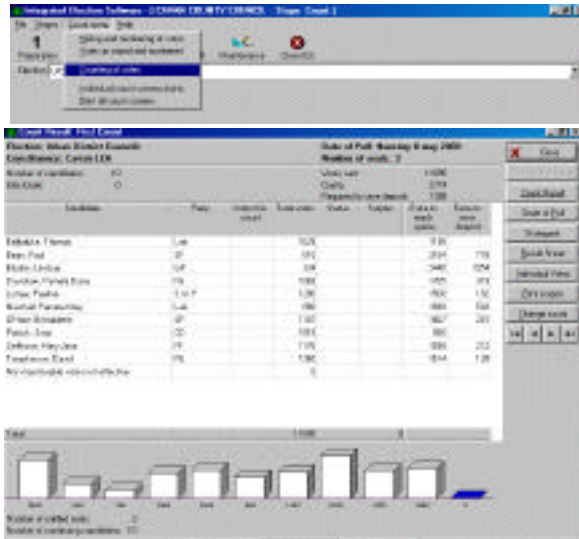
The solution called Election Management System (EMS) includes the use of voting machines and dedicated Integrated Election Software (IES). Since the selection of this solution, the Department of Environment, Heritage and Local Government has worked closely with Powervote Limited, Nedap NV and returning officers to ensure that the system is fully validated before use at an election. In addition the system hardware and software has been rigorously tested by recognized international test institutes and companies.

This document includes the following information:

- A description of the dedicated Integrated Election Software (IES)
- An outline of the voting and vote counting processes using the system

This document does not provide a detailed explanation of the systems and components discussed within. It is an overview. Other relevant documentation on the voting machine and software are referred to in the document and enquiries, etc should be made to the Department of the Environment, Heritage and Local Government.

2 System Components



EMS Software System

IES transfers Election setup to ballot module
 Votes are read from the ballot module into the IES database



Ballot Module

Voting Machine reads election setup from ballot module
 Votes are stored on ballot module



Votes being cast on the Nedap Voting Machine

Direct vote recording and electronic vote counting depend upon three important components:

1. The IES system. This software package, running on a Microsoft Windows computer, allows the election official to set up and record the details of an election. When voting is completed, it counts the votes and displays the outcome of the count results in the format Irish voters are familiar with. The PC's used are stand alone and security hardened for the election software only. Access to the PC's is also controlled by a security key.
2. The Nedap Voting Machine replaces the ballot paper, ballot box and polling booth. It is located in the polling station. This portable device provides voters with a secure mechanism for recording their candidate(s) preference(s) by pressing buttons on the large screen panel, and then casting their votes by pressing the "Cast Vote" button.
3. The ballot module is a small portable electronic device, which is used for storing and transferring information between the IES and the Nedap Voting Machine. The set-up of the election candidates is programmed onto the ballot module and read by the voting machine. As votes are cast, they are recorded in the ballot module. When the polling station closes, the ballot module is sent to the count centre and the votes are transferred from the ballot module into the IES system.

2.1 Voting Machine



The Nedap Voting Machine is a suitcase sized portable voting unit. It provides a secure, private and straightforward voting experience for those casting their votes. There can be no spoiled votes. The voter must select a preference or preferences before the machine will accept a vote when the “cast vote” button is pressed.

When a voter advances to the machine, a member of the polling station staff activates the appropriate “ballot paper(s)” on the voting machine using a separate control unit. The polling station staff member has no access to the voting machine while a voter is present at the machine.

When cast, the vote is recorded randomly in the *ballot module*. At close of the poll the votes in the ballot module are copied to a back-up ballot module in the voting machine.

2.2 Integrated Election System (IES)

The IES was first developed in 1988 in The Netherlands. Each country using this software (The Netherlands, Germany and Ireland) has its own specific election rules and these have been incorporated into the software. Ireland’s use of the software represents the first time the software has been adopted by a country for all election types (comprising local, general, Presidential and European elections and referenda).

2.2.1 Operating System Software and Hardware

The IES runs on a standard computer running Microsoft Windows 2000 or later versions. It consists of approximately 200,000 lines of code in 300 source code units. When in use the system records data in a Microsoft Access database. Typically the software is reinstalled before each election as a security feature and to ensure that all updates to election legislation are reflected in the software used for the election.

PCs with the software are dedicated for election work and are not connected to a network to ensure security and privacy.





2.2.2 Development Environment Used

The software is updated as necessary to reflect both legislation and the technology advances.

- Borland Delphi 5. A widely used compiler for creating Microsoft Windows applications. This compiler uses Object Pascal as its programming language. The compiler delivers stand alone executable applications for speed and simplicity of installation.
- Opus DirectAccess provides Delphi programs with a comprehensive, efficient interface to Microsoft Access databases. It replaces Delphi's normal database interface (BDE) with a much leaner intermediate layer that talks directly to the native Access database engine (DAO).
- TurboPower's Async Professional is a collection of native Visual Component Library (VCL) components that provide serial communication facilities for programs created with Borland Delphi. It provides optimised components that are fully integrated with Delphi and compile directly into EXE files. Async Professional provides a wide range of serial communication components ranging from a simple COM port component, which is used to control the serial port hardware, to Voice Processing software.
- MULTILIZER® Developer Edition ("Multilizer") is a software globalization solution for developers of numerous programming environments. It provides the IES with the ability to target users of many different languages without the need to develop separate software solutions for each language.

2.2.3 Database used by the system

The IES uses Microsoft Access for storing the votes. Microsoft Access is a 32-bit Desktop Relational Database. It was first released in 1992 and has had several iterations up to the latest version Microsoft Access XP. The IES application is compatible with all versions of Access from Access 97 onwards. This database gives IES the ability to operate independently of other computer systems for the election process.

3 Voting Process

The following section indicates the steps involved in direct vote recording using the Nedap Voting Machine and IES as modified for the Irish election process.

3.3 Election Preparation

3.3.1 Set up of election in the IES

The following activities must be completed successfully to set-up an election using IES:

- The election official registers with the software developer for support purposes and then establishes that the connection with the programming unit (which transfers the election set-up to the ballot module) is operational.
- Polling station details are entered into a basic referral file. From this file the polling stations for a particular poll are selected into an active file. The number of voters per polling station is recorded. This enables detailed turnout figures to be calculated as part of the control and reporting facility of IES.
- Data relating to political parties and candidates (including photographs) are entered for each constituency.
- Create result files are created by an internal IES process, which is active when all the preparation stages have been completed.
- One ballot module per voting machine is programmed via a programming unit.
- Files for the printing of the voting machine ballot paper(s) are copied to a disk for transmission to a commercial printer.



3.3.2 Download of Election to Voting Machine



The election official programmes a ballot module (each has a uniquely identifiable number) via a programming unit attached to the back of the PC running the IES. The ballot module is then inserted into a voting machine designated for a specific polling station.

3.4 Casting Votes by the Electorate

The following describes the procedures at a polling station.

3.4.1 Casting a vote

When a person arrives at the polling station to cast his or her vote(s), he or she (as usual) approaches a desk to be identified and marked off the register of electors. Instead of being handed ballot paper(s) as in the past, a voter will receive a permit ticket which he or she must present to the official in charge of the voting machine before being allowed to vote. The official activates the voting machine to enable the voter to use it. The voter views the ballot paper(s) on the voting machine and selects preferences by pressing the buttons beside the candidates' photographs on the ballot paper. Once the preferences are entered, the voter presses the "Cast Vote" button to cast his or her vote(s). The official (who is positioned to the back or side of the voting machine) is made aware of this by a signal on the Control Unit. The votes cast are then recorded randomly in the ballot module. The system utilises a system timer, which changes one hundred and twenty five times per second in order to establish the random position of the next vote to ensure that a vote recorded cannot be linked with the voter marked in the register of electors.



3.4.2 Closing the poll

When the poll closes, the following activities take place.

- The voting machine prints a statement showing the number of voters who used the machine and a list of candidates in ballot paper order.
- At the same time, the votes recorded in the ballot module are backed-up to a second ballot module in case the primary ballot module is lost or damaged.
- The primary ballot module and statement are sent to the returning officer at the count centre.

3.4.3 What if....

The system has been designed with a number of backup measures:

- Spare voting machines are available in case of a malfunction of the Nedap Voting Machine.
- All votes cast are transferred to a backup ballot module inside the voting machine when the poll closes.
- An optional portable battery is available in case of blackouts.
- Technical support will be available on polling day and at the count centre.

3.5 Counting the Votes

3.5.1 Reading votes into the IES

When received from the polling station, the ballot module is inserted into the reading slot on the programming unit connected to the back of the PC running the IES. The contents are verified by the software to ensure that the ballot module is in fact the original module programmed by the IES and sent to the polling station. The system then downloads the votes cast into a database of the IES.



3.5.2 The Count



Less space and counting staff are required than for a paper count but access for candidates and their agents will remain the same. As the contents of the ballot modules are read by the IES, the ballot modules are placed into a storage case. At the end of the count the modules are sent to the Clerk of the Dáil (for a Dáil election) for retention for six months after which the vote data is erased.

3.5.3 Prerequisites of starting a count

When all the ballot modules have been read into the IES, voting data in the system is released so that the counting of the votes can begin.

3.5.4 Mixing and numbering the votes

In this stage, all the votes for the constituency loaded into the system are randomly mixed and renumbered in accordance with the legislation. The software system utilises a widely used computer algorithm called the Lehmer algorithm. It implements a pseudo-random number generation process and begins with a seed value generated, again, from the system clock. It then generates a random number in the range 1 to 2^{32} . After each vote has been allocated a random number, this random number is used to reorder the votes. After reordering the votes, the system replaces the generated random number with a number reflecting the position of the vote in a vote table.

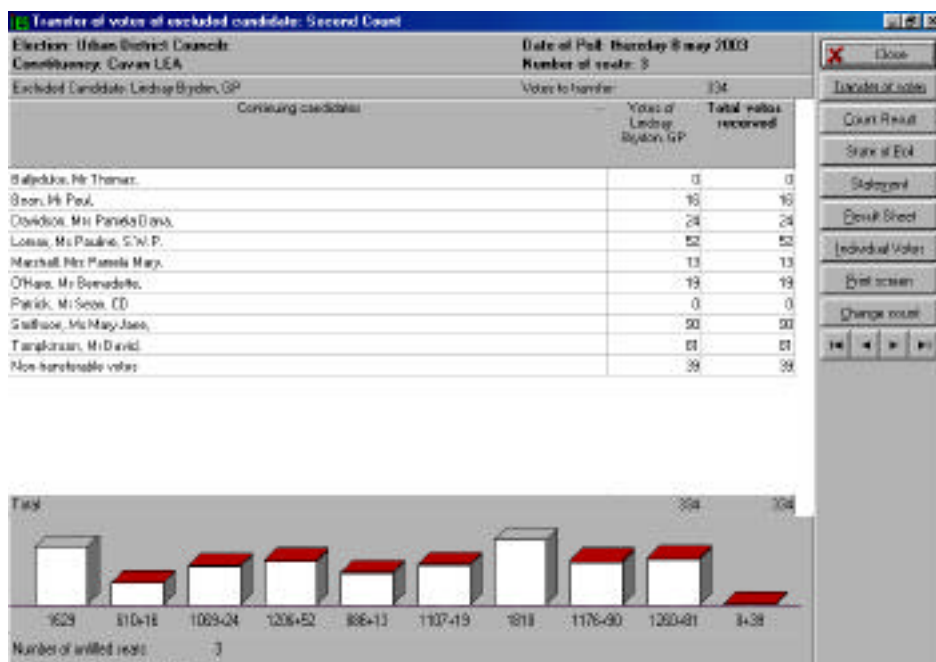
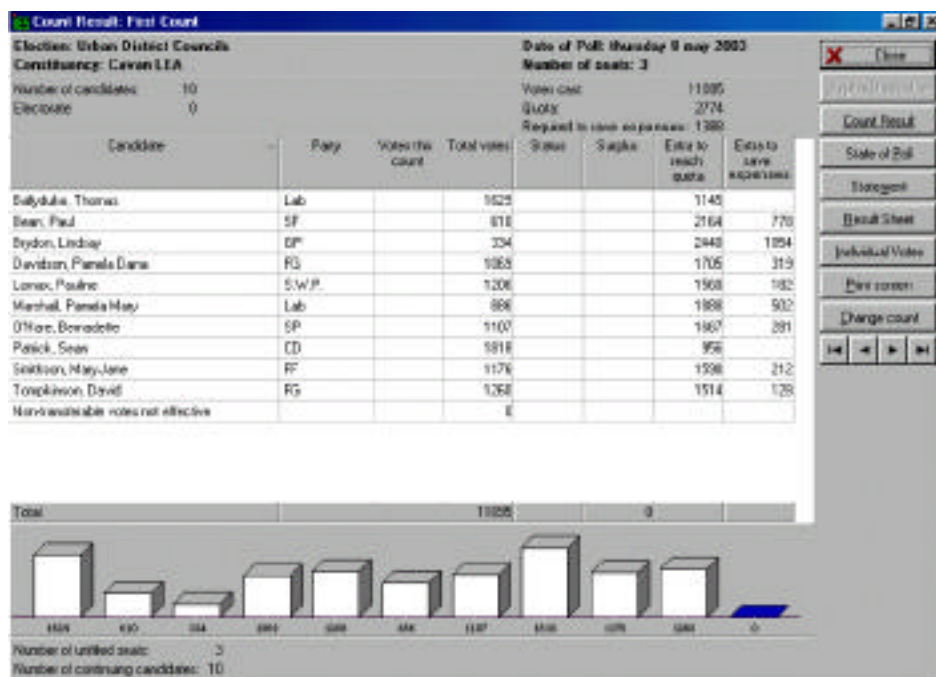


3.5.5 Counting the votes

Following the mixing and numbering of the votes, the IES implements the Irish election count rules (PR_STV) in full and applies these rules to the votes in the system. The system will stop after each individual count and also in the event of ties, which require the “drawing of lots” by the returning officer. When complete, all the counts are recorded in the system’s database.

3.5.6 Displaying the count details

The software system records and displays each count in an easy to read format:





3.6 Final Result

Once the count is complete, the results can be viewed on screen and count totals printed for distribution to candidates, agents and others.

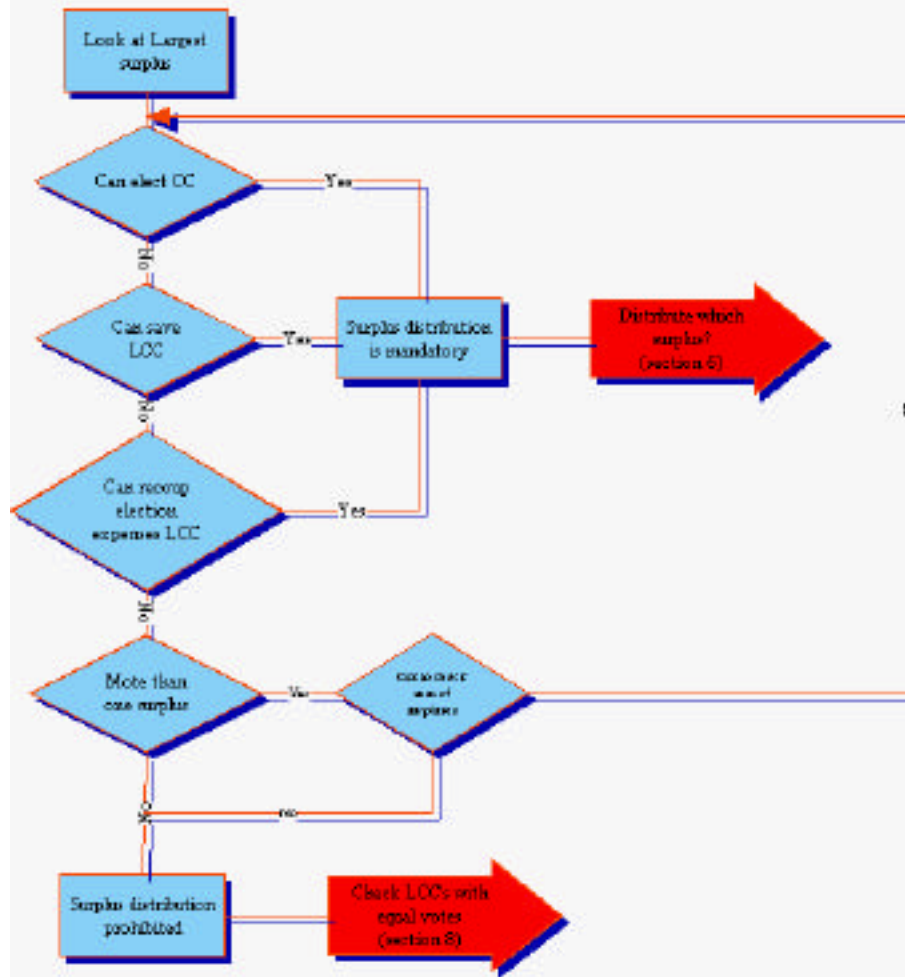
Post-Count Result Sheet							
Names of candidates (10 No.) [* Denotes outgoing member]	First Count	Second Count	Third Count	Fourth Count	Fifth Count	Sixth Count	Seventh Count
	Number of first preference votes cast for each candidate	Transfer of Lindsay Brydon, GP Votes and Result	Transfer of Paul Bean, SF Votes and Result	Transfer of Pamela Mary Marshall, Lab Votes and Result	Transfer of Bernadette O'Hare, SP Votes and Result	Transfer of Pauline Lomax, S.W.P. Votes and Result	Transfer of Pamela Dana Davidson, FG Votes and Result
Ballyduke, Mr Thomas,	1629	1629	1629	1629	1629	1629	1629
Bean, Mr Paul,	610	+16 626	-626	-	-	-	-
Brydon, Mr Lindsay,	334	-334	-	-	-	-	-
Davidson, Mrs Pamela Dana,	1069	+24 1093	+99 1192	+287 1479	-	1479	-1479
Lomax, Ms Pauline, S.W.P.	1206	+52 1258	+66 1324	+28 1352	-1352	-	-
Marshall, Mrs Pamela Mary,	886	+13 899	+58 957	-957	-	-	-
O'Hare, Ms Bernadette,	1107	+19 1126	+104 1230	+11 1241	-1241	-	-
Patrick, Mr Sean, CD	1818	1818	1818	1818	1818	1818	1818
Smithson, Ms Mary Jane,	1176	+90 1266	+40 1306	+396 1702	1702	1702	1702
Tompkinson, Mr David,	1260	+81 1341	+61 1402	+111 1513	1513	1513	1513
Non-transferable votes not effective	-	+39 39	+198 237	+124 361	+1241 1602	+1352 2954	+1479 4433
Total	11095	11095	11095	11095	11095	11095	11095

4 Further Documentation

Further relevant documentation is available from the Department of the Environment, Heritage and Local Government (see Web site www.environment.ie or www.electronicvoting.ie) including:

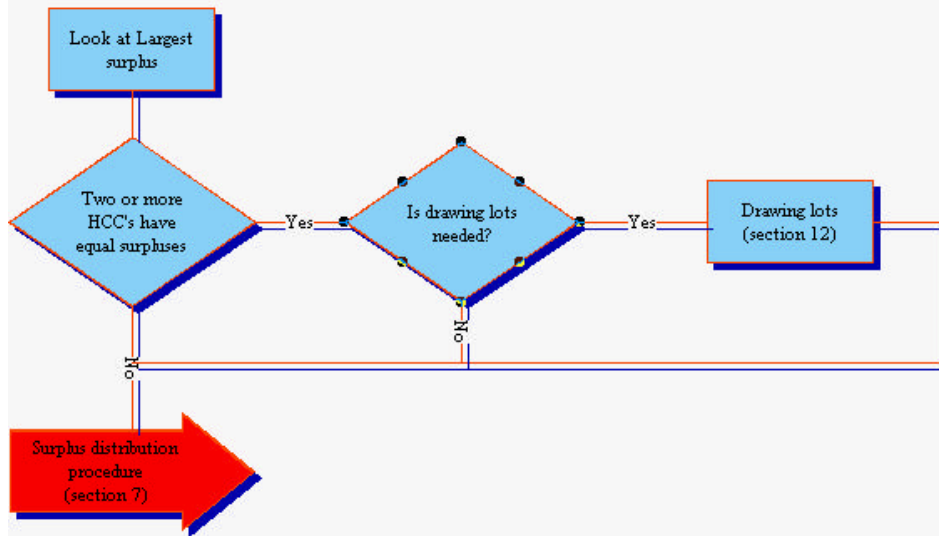
- Voting machine functional specification
- Voting machine software specification
- Count rules requirements
- Test Reports

Detail-Flowchart of Surplus distribution - mandatory or prohibited (section 5)



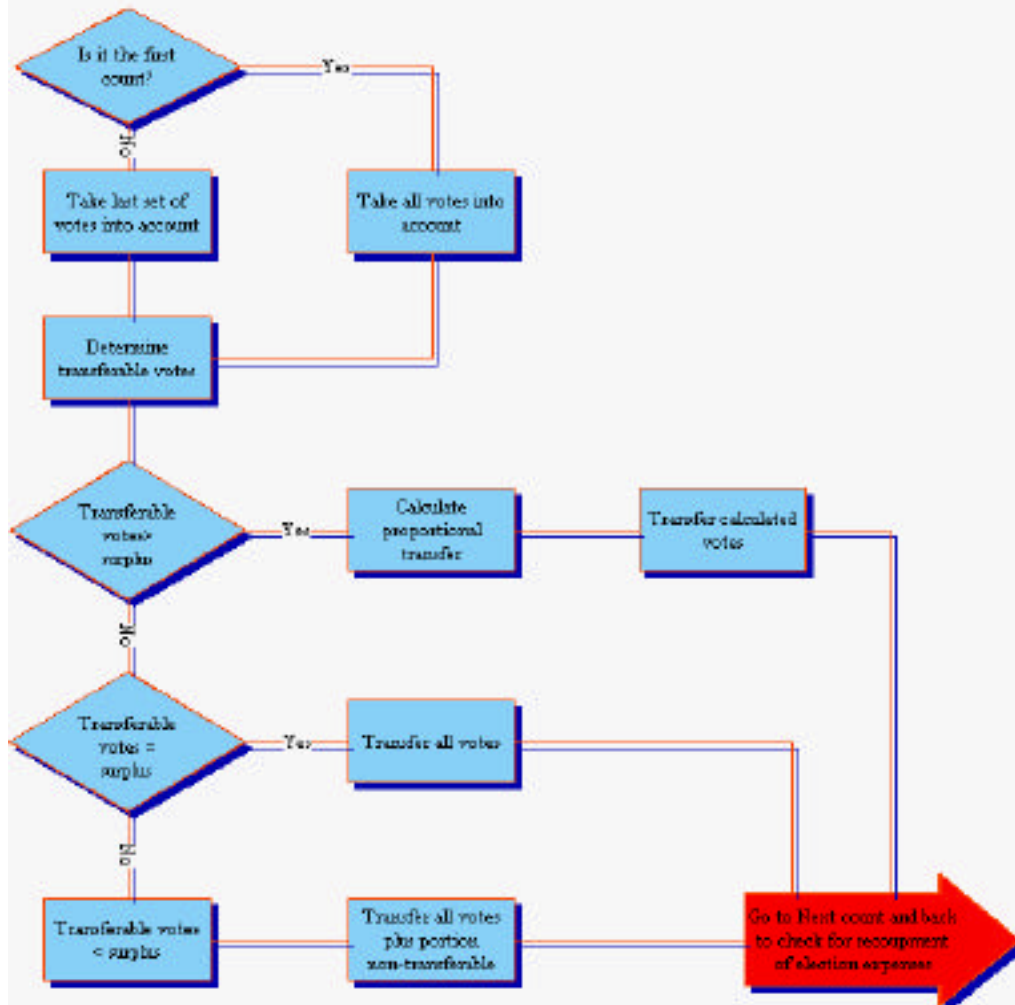
*HCC = Highest Continuing Candidate
LCC = Lowest Continuing Candidate
CC = Continuing Candidate
SR = Seats Remaining*

Detail-Flowchart of distribution which surplus (section 6)



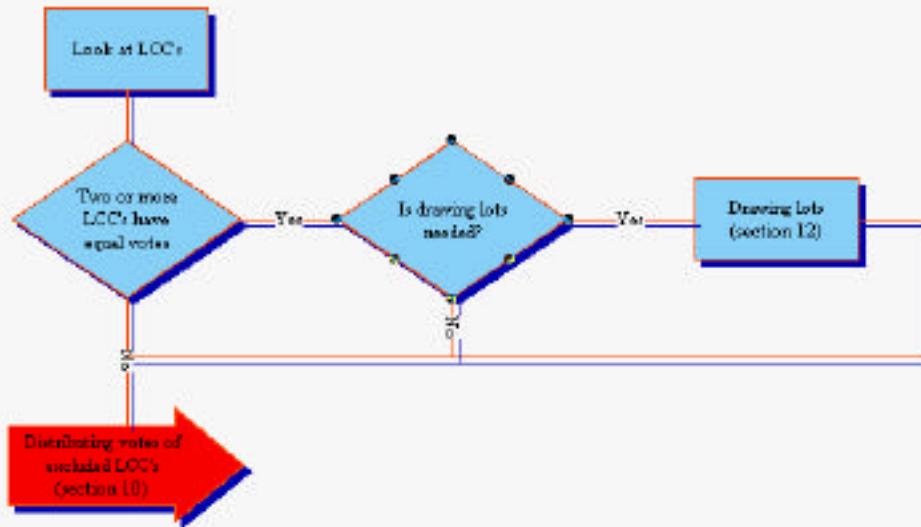
HCC = Highest Continuing Candidate
LCC = Lowest Continuing Candidate
CC = Continuing Candidate
SR = Seats Remaining

Detail-Flowchart of the Surplus distribution procedure (section 7)



*HCC = Highest Continuing Candidate
LCC = Lowest Continuing Candidate
CC = Continuing Candidate
SR = Seats Remaining*

Detail-Flowchart of solution for two or more lowest candidates with equal votes (section 8)



HCC = Highest Continuing Candidate
LCC = Lowest Continuing Candidate
CC = Continuing Candidate
SR = Seats Remaining

Detail-Flowchart of logic for excluding two or more lowest candidates together (section 9)

